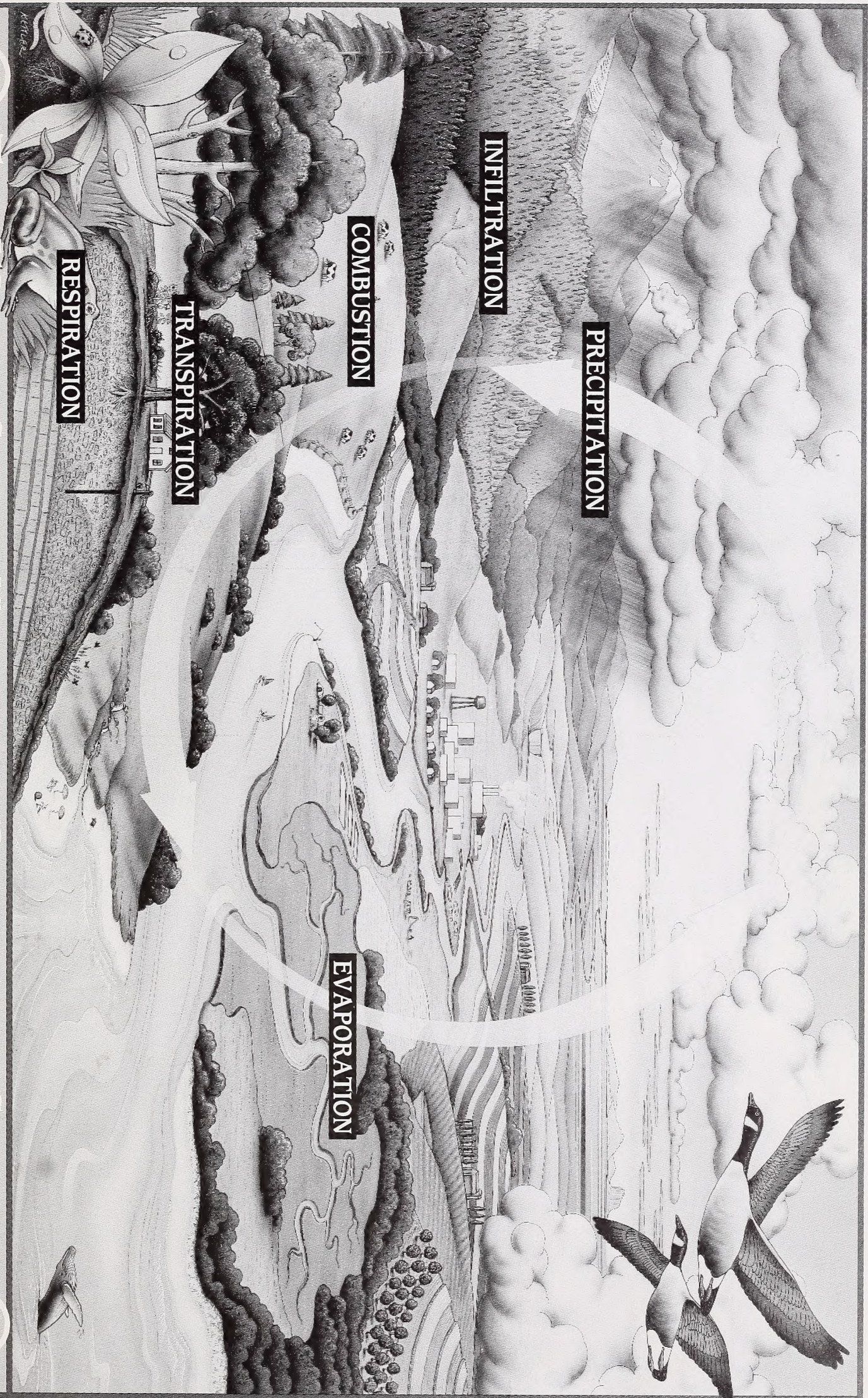


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PRECIPITATION

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THE WATER CYCLE: NATURE'S RECYCLING SYSTEM



THE WATER CYCLE - NATURE'S RECYCLING SYSTEM

The definition of recycling is “to pass through a cycle or a part of cycle again” (Webster’s New World Dictionary-Third College Edition, 1988, Simon and Schuster, NY). Nothing fits that definition better than the HYDROLOGIC, or water, cycle. The hydrologic cycle is a perpetual motion — a natural process of water molecules recycling from the land, to the air, and back to the land.

The sun’s energy warms water, which is transferred as vapor from the oceans, seas, and land masses into the atmosphere. Once in the atmosphere, the vapor is formed into clouds. The clouds are carried by weather patterns, which are influenced by the topography of the Earth’s surface. Sometimes vapor condenses as fog, mist, or clouds, and sometimes it falls to the Earth as precipitation, where it is accumulated in surface water and the soil. Then the process of

recycling, or returning the water back into the atmosphere, continues.

The key processes in the hydrologic cycle are evaporation, transpiration, precipitation, and infiltration. Other processes are respiration and combustion.

To trace the movement of the water through this cycle, begin at the far right where the sun’s energy is evaporating water from the sea into the atmosphere. As vapor leaves the oceans and the drier lands, it leaves behind minerals, like salts, which can make land inhospitable. But in the oceans, it is only a part of a natural process without damage to the sea life.

The unseen water vapor then joins the procession of water molecules on a journey that will lead them back to the land or water as precipitation. The precipitation may take any one of several forms, but will

always start out as frozen water. The molecule attaches itself to some sort of airborne debris and is then tumbled and tossed toward the Earth's surface. Whether the water ends up as a raindrop, snow crystal, or hail, is dependent upon the season, location, and climate.

Not all the water will reach the Earth. Some will evaporate on the way between the sky and the land and then return to the atmosphere to start the process over again.

Once the water reaches the Earth, it will either run off across the land surface, infiltrate (fill the pore spaces between individual soil particles), or fall into bodies of water.

Runoff is intercepted by conservation practices, such as small dams, terraces, and grassed waterways. These practices allow the water to either infiltrate or be retained as surface water. (See more about conservation - page 5.)

Small amounts of water are retained and held by plants, buildings, automobiles, machines, and other

structures until they evaporate back into the atmosphere. As automotive and other engines do their job of powering vehicles, some of their waste material is also water vapor being expelled into the atmosphere through the process of combustion or burning. And animals respire water vapor when they breathe.

Most of the water infiltrates into the soil. Some water will be drawn up by plant roots, then transpired, or given off through the leaves, back into the air as water vapor. Other water will move slowly into underground aquifers, percolating through the soil into the bedrock. Eventually, through wells or irrigation, the groundwater may be drawn back up and used.

Other water will move slowly through the soil and bedrock until it reaches the surface in the form of a seep, spring, or artisan well.

Excess water will run off across the land's surface into various bodies of water, taking with it precious soil and anything that was attached to individual soil particles. Then the evaporation process — like transpiration, respiration, and combustion — begins anew. And the never-ending recycling of water continues.

ABOUT WATER

Although water is all about us, seen and unseen, we still find it mysterious and, in many ways, one of the least known of all the natural resources.

We all have first-hand experience with water; every day, every minute. As we breath, inhaling then exhaling, we are respiring waste material, including water vapor. That water vapor comes from the water we drink, the food we eat, and the air we breathe.

Water surrounds us. It is in the air as rain, ice, snow, steam, and fog. It is in lakes, streams, rivers, oceans, and glaciers. It makes up most of the volume of plants and animals, including humans. Humans are about 65% water. Your blood is about 80-90% water, and your muscles are about 75% water. To keep your body operating, you will need about 5 1/2-6 pints (2.6-2.8 litres) of water a day. Although a person can exist on a gallon (3.6 litres) of water a day for drinking, cooking, and washing, this seldom happens. Today, a person in modern western nations uses between 80-100 gallons (300-380 litres) of water per day. That is in comparison to the three to five gallons (10.8-15 litres) used per person in medieval times.

When you go to the water fountain to get a drink of fresh, clean water, that water is new to you. But it really isn't new water at all. That water has been recycled time and time again, from the very beginnings of the Earth, through numerous life forms like a dinosaur, a rabbit, an alligator, or even Abraham Lincoln. One very important fact to remember is that, at this moment we have all the water we will ever have, or ever have had. No new water is being manufactured.

Exactly what is water? Simply speaking, it is two hydrogen atoms attracted to and bonded to one oxygen atom. The hydrogen atoms allow high freezing and boiling temperatures.

Although the Earth's surface is about 75% water, only about 3% is fresh water; of that, 75% is found in polar ice caps and glaciers, making its economical use practically non-existent. Consequently, the amount of water available to humans, relatively speaking, is ample but may be limited...depending on where you live.

WATER AND CONSERVATION

Although there is little control over the hydrologic cycle, and the primary water supply is firmly fixed, water can generally be managed and conserved as it becomes available through precipitation.

Water management begins with soil management. Because the water supply comes to us as precipitation falling on the land, the destiny of each drop of rain, snowflake, and hailstone depends largely on where it falls—and on the kind of soil and its covering.

Soil erosion begins with a drop of water blasting, like a small bomb, soil particles. The soil begins to move, and small rills are formed as the water finds its way across the soil surface. Unchecked, it will result in a large gully. Over several million years, that gully could turn, quite literally, into the Grand Canyon found in the southwestern United States.

Another form of erosion is sheet erosion, which, like the name indicates, moves the soil surface in a large, usually unseen, thin sheet.

Erosion takes place anywhere there is bare soil, on farms, ranches, school yards, new construction sites, homes, parks,

and forests. A rainstorm or heavy shower drops millions of tons of water on the land. The force of that water can severely affect the landscape if proper precautions haven't been taken. Drop by drop, the water beats away at the soil, loosening soil particles and moving them short distances or even far away. This action, soil erosion by water, is a natural event.

Erosion is the source of sediment that fills reservoirs, lakes, and streams with potential pollutants that could kill aquatic life. The sediment can shorten the life span of dams and reservoirs, clog navigation channels, and affect the quantity and quality of water delivered to towns and cities.

Water and bare, unprotected soil equals an erosion problem that can be controlled through vegetative conservation practices. The idea is to intercept and reduce the impact of the falling or running water, allowing the water to either soak into the soil for later use by plants, or to safely and carefully run off in a controlled manner.

The branches and leaves of grass, trees, bushes, shrubs, and even weeds, help break the force of raindrops and hold the soil in place. Mulching protects the soil when it has no growing

cover. Small dams on upper tributaries in watersheds help control the flow of water and protect the streams from accelerated erosion.

Where cultivated crops are grown, plowing and planting on the contour, terracing, and using grassed waterways to carry surplus water from the fields are some of the conservation practices that slow running water and protect soil from erosion.

In cities and suburbs, where much of the land is covered by streets, buildings, shopping centers, airports, and industrial developments, precipitation runs off as much as ten times faster than on unpaved land. And, since this water cannot soak into the soil, its volume is increased as it flows into storm drains or through sewer systems. As it moves with such velocity and volume, it will pick up and carry debris and other pollutants to streams and rivers.

In urban areas, the same basic water conservation and management principles apply: intercept the force of the running water, slow it down, control it, and reduce the amount of water leaving the land surface.

As populations grow, the demand for water for human uses increases. Yet there is only so much water available. The use of water in industrialized nations continues to grow. Sound management of the water available affects the quantity and quality of water to meet the needs of expanding populations, often in locations with little water supply.

WATER FACTOIDS

- Every year, 80,000 cubic miles (330,000 km³) of water evaporate from the oceans.
- Every year, about 15,000 cubic miles (63,000 km³) of water evaporate from the Earth's land sources.
- About 95,000 cubic miles (400,000 km³) of water are moving between the Earth and sky at all times.
- Only about 24,000 cubic miles (100,000 km³) of water actually get to the land as precipitation.
- Land precipitation averages 26 inches (660 mm) a year.
- Some places, like deserts, get less than an inch (25 mm) of water a year; while others, like tropical rain forests, may get more than 400 inches (10,000 mm) a year.

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ACTIVITIES

Class Participation - Evaporation

Objective

To show that some water is initially captured by soil and that, over time, it evaporates back into the atmosphere.

Materials Needed

- Two paper cups for each student
- Scales
- Enough soil to fill one cup for each student
- Measuring cup or graduated cylinder

Procedure

Fill each cup with soil to within 1/2 inch (13 mm) of the top. Weigh the filled cup and record the weight.

Poke small holes in the bottom of the filled cup to allow water to run through.

Gently pour two cups of water over the soil

surface while a partner holds a second cup beneath the filled one to capture the water that runs through.

Weigh the filled cup and record this wet weight. Weigh and record on three successive days.

Questions for Discussion

How does this laboratory situation compare to the actual situation of rain falling on the ground?

What happened to the water held by the soil initially?

What is likely to happen to it now that it has evaporated?

How does water get into the atmosphere from plants?

Class Discussion - Water, the Resource

Objective

To start students thinking about water as a limited resource and considering their role in water conservation.

What are some of the ways we use water each day in our homes?

What are other ways in which we use water?

How can we as individuals help in the effort to conserve water?

Class Participation - Comparison of Family Water Uses

Objective

To make students more aware of the large amounts of water used in individual households.

Materials Needed

- Graph paper
- Pencil

Procedure

Have each student record the amount of water used in their home over the period of a school day. This figure can be obtained by reading the home water meter first thing on two consecutive mornings or by estimating toilet flushes (5 gallons or 20 litres), showers (35 gallons or 130 litres), washing clothes (40 gallons or 150 litres), and using the dishwasher (10 gallons or 40 litres).

Ask the students to graph the water use of all the families.

Questions for Discussion

Was there a lot of variation in water use among families?

Did most families fall within the average use of 80-100 gallons (300-380 litres) per person per day?

Did some families use either a lot less or a lot more than the average?

What are some possible reasons for using either more or less?

What are some ways that water consumption could be cut?

Demonstration - The Water Cycle

Objective

To show that the water we use is the same water that has been in use since the beginning of time. To demonstrate that an element that enters the water cycle remains in the system.

Materials Needed

- Clear plastic box with clear lid
- Heat lamp
- Plastic bag of ice
- Food coloring

Procedure

Prop the box at a 30 degree angle.

Pour 3.5 ounces (100 ml) of water in the box.

Replace the lid.

Focus the heat lamp on the lower portion of the box to create evaporation.

Secure the ice at the top of the box at the opposite end to create condensation.

Once the cycle of evaporation, condensation, and precipitation is established, add food coloring to the water in the box.

Questions for Discussion

What process is recreated by turning on the heat lamp?

What process is recreated by applying ice to the water vapor that collects in the lid of the box?

What principle does the addition of the food coloring demonstrate?

Does this mean that rain is pure?

Demonstration - Percolation

Objective

To demonstrate that water percolates through soils with different grain sizes at different rates

Materials Needed

- Five plastic columns, 40 inches (100 cm) long and 2 inches (5 cm in diameter)
- Five gauze pads and rubber bands
- Five beakers to catch the water that percolates through each column
- Samples of clay, coarse sand, fine sand, gravel, and topsoil or 5 graduated sizes of plastic beads, approximately 2 measuring cups of each
- Measuring cup
- Stopwatch

Procedure

Secure a gauze pad to the bottom of each column with a rubber band.

Place a different soil sample or size of bead in each column until the column is approximately half full. Make sure all columns are filled to the same level.

Pour 3.5 ounces (100 ml) of water through the columns, one by one.

Time the passage of the water through each column.

Measure the amount of water that passes through each column.

If using soil samples, note the color of the water in the collection beaker.

Questions for Discussion

Did the water go through all of the columns at the same rate?

If not, why not?

Describe the relationship between the rate at which water passes through the soil and the size of its grains.

Class Participation - Snow Density

Objective

To show that snow is comprised of water and air and that the density of the snow affects the amount of water produced when snow melts

Materials Needed

- Two small cans of the same size, one opened on both ends
- Ruler and masking tape

Procedure

Measure and record the height of the can as the depth of the snow.

Push the can that is open on both ends down through the snow until the can is full of snow.

Carefully pull the can up to keep any of the snow from falling out.

Place the can over the opening of the other can and tape them together so all the melting snow falls into the lower can.

After the snow has melted, dip the ruler into the water and measure and record the depth.

Questions for Discussion

What is the relationship between the amount of snow collected and the amount of water produced?

How is the density of the snow calculated?

What are some of the factors that affect the density of snow?

Would the snow density be the same at the top and bottom of a deep snowpack?



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